Predicting Redox Reactions, Extra Exercises

For each of the following questions, use the five-step method outlined in *Nelson Chemistry 12* on page 682 to predict and communicate the most likely redox reaction, and use the spontaneity rule to predict whether the reaction will occur spontaneously.

1. An aqueous solution of potassium permanganate was reacted with an acidic solution of sodium bromide and an orange-brown substance was formed.

2. A strip of silver metal is placed in a solution of aqueous nickel(II) chloride.

3. Liquid mercury is mixed with a paste of acidic manganese(IV) oxide.

4. Hydrogen peroxide and silver nitrate are mixed.

(continued)

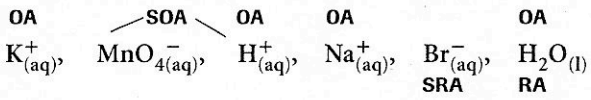
5. Potassium metal is placed into some water.

6. In a car battery lead and lead(IV) oxide electrodes are exposed to a sulfuric acid electrolyte. (Assume that the sulfuric acid ionizes to hydrogen and sulfate ions.)

Predicting Redox Equations, Extra Exercises, Solution

For each of the following questions, use the five-step method outlined in *Nelson Chemistry 12* on page 682 to predict and communicate the most likely redox reaction, and use the spontaneity rule to predict whether the reaction will occur spontaneously.

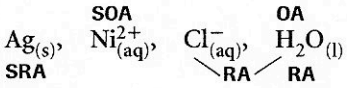
1. An aqueous solution of potassium permanganate was reacted with an acidic solution of sodium bromide and an orange-brown substance was formed.



$$2\,[MnO^-_{4(aq)} + 8\,H^+_{(aq)} + 5\,e^- \rightarrow Mn^{2+}_{(aq)} + 4\,H_2O_{(l)}]$$
$$5\,[2\,Br^-_{(aq)} \rightarrow Br_{2(l)} + 2\,e^-]$$

$$2\,MnO^-_{4(aq)} + 16\,H^+_{(aq)} + 10\,Br^-_{(aq)} \xrightarrow{\text{spont.}} 5\,Br_{2(l)} + 2\,Mn^{2+}_{(aq)} + 8\,H_2O_{(l)}$$

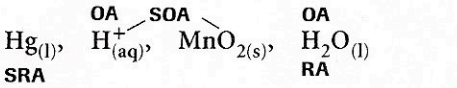
2. A strip of silver metal is placed in a solution of aqueous nickel(II) chloride.



$$Ni^{2+}_{(aq)} + 2\,e^- \rightarrow Ni_{(s)}$$
$$2\,Ag_{(s)} \rightarrow 2\,Ag^+_{(aq)} + 2\,e^-$$

$$2\,Ag_{(s)} + Ni^{2+}_{(aq)} \xrightarrow{\text{non-spont.}} Ni_{(s)} + 2\,Ag^+_{(aq)}$$

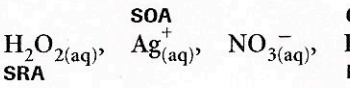
3. Liquid mercury is mixed with a paste of acidic manganese(IV) oxide.



$$MnO_{2(s)} + 4\,H^+_{(aq)} + 2\,e^- \rightarrow Mn^{2+}_{(aq)} + 2\,H_2O_{(l)}$$
$$Hg_{(l)} \rightarrow Hg^{2+}_{(aq)} + 2\,e^-$$

$$MnO_{2(s)} + 4\,H^+_{(aq)} + Hg_{(l)} \xrightarrow{\text{spont.}} Hg^{2+}_{(aq)} + Mn^{2+}_{(aq)} + 2\,H_2O_{(l)}$$

4. Hydrogen peroxide and silver nitrate are mixed.



$$2\,Ag^+_{(aq)} + 2\,e^- \rightarrow 2\,Ag_{(s)}$$
$$H_2O_{2(aq)} \rightarrow O_{2(g)} + 2\,H^+_{(aq)} + 2\,e^-$$

$$H_2O_{2(aq)} + 2\,Ag^+_{(aq)} \xrightarrow{\text{spont.}} Ag_{(s)} + O_{2(g)} + 2\,H^+_{(aq)}$$

(continued)

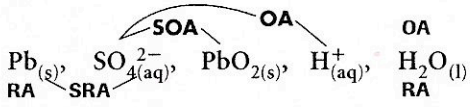
5. Potassium metal is placed into some water.

$$2\,H_2O_{(l)} + 2\,e^- \rightarrow H_{2(g)} + 2\,OH^-_{(aq)}$$
$$2\,K_{(s)} \rightarrow 2\,K^+_{(aq)} + 2\,e^-$$

spont.

$$2\,K_{(s)} + 2\,H_2O_{(l)} \rightarrow H_{2(g)} + 2\,K^+_{(aq)} + 2\,OH^-_{(aq)}$$

6. In a car battery lead and lead(IV) oxide electrodes are exposed to a sulfuric acid electrolyte. (Assume that the sulfuric acid ionizes to hydrogen and sulfate ions.)



$$PbO_{2(s)} + SO^{2-}_{4(aq)} + 4\,H^+_{(aq)} + 2\,e^- \rightarrow PbSO_{4(s)} + 2\,H_2O_{(l)}$$
$$Pb_{(s)} + SO^{2-}_{4(aq)} \rightarrow PbSO_{4(s)} + 2\,e^-$$

spont.

$$Pb_{(s)} + PbO_{2(s)} + 4\,H^+_{(aq)} + 2\,SO^{2-}_{4(aq)} \rightarrow 2\,PbSO_{4(s)} + 2\,H_2O_{(l)}$$